

REMARKS

The Examiner rejected all pending claims 1-16 and 21-29 pursuant to 35 U.S.C. § 103(a) as unpatentable for obviousness over various cited references. The different combinations as they related to specific claims are addressed below. New claims 30-38 have been added to further delineate the novelty and non-obviousness of the invention and its patentability over the cited art. No new matter has been added. Support for the amendments and new claims can be found, by way of example only, in paragraphs [0004]-[0005], [0008], [0014], [0024]-[0036], and in the drawings as accepted by the examiner. Reconsideration of the rejections is requested based upon the remarks and arguments presented below.

Ngan in View of Houchin

The examiner rejected claims 1-9, 21-23, and 25-26 as obvious over Ngan (U.S. Pat. No. 5,919,342)(“Ngan”) in view Houchin et al. (U.S. Pat. No. 5,202,095)(“Houchin”). Applicant respectfully disagrees and requests reconsideration of the rejection.

To establish a *prima facie* case of obviousness, three basic criteria must be met: (1) there must be a suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; (2) there must be a reasonable expectation of success; and (3) the reference(s) must teach or suggest all the claim limitations. MPEP § 706.02(j).

Here, the examiner has indicated that “Ngan does not clearly teach wherein the helical electrode comprises a ribbon coil having a width that is greater than its thickness.” The examiner nevertheless maintains that Houchin teaches a ribbon coil. This argument cannot suffice to find the present invention unpatentable because Houchin actually teaches away from the present invention.

In the present invention, as disclosed and taught in the cited claims, the helical ribbon coil is much wider than it is thick. See paragraph [0032] of the present application (“The coil 172 has a width that is substantially greater than its thickness”). As set forth in claim 1 as amended, the helical ribbon coil is, “configured as stacked flat concentric spirals,” and has an “axis oriented parallel to a direction of stacking, each said ribbon coil having a width and a thickness, said width being greater than the thickness, the thickness being substantially parallel to the axis, and the width being substantially perpendicular to the thickness.” The advantage of this configuration is that the helical ribbon electrode of the present invention can be placed closer to the substrate/wafer than prior art

electrodes, and can maintain plasma uniformity on the wafer surface. See paragraph [0029] of the present application.

In contrast, the coil disclosed Fig. 2 of Houchin is narrow where the helical ribbon electrode of the present invention is wide, and is thick where the present helical ribbon electrode is flattened. Nor does the coil disclosed in Houchin appear to be a “flat concentric spiral” as does the helical ribbon coil disclosed in the present application. In fact, the specification further establishes that Houchin teaches away from the present invention. Specifically, the coil in Houchin does not have a 1:100 or 1:10,000 thickness-to-width ratio as disclosed in the present application. Instead, Houchin discloses that the “microwave radiation antenna” helical coil has an inner diameter of 60 mm and an outer diameter of 72 mm, leaving a thickness of 12 mm. The length of helical coil (apparently corresponding to the thickness) is stated to be 170 mm. Houchin Col. 2, ll. 63-66. Thus, in Houchin, the thickness-to-width ratio is 170:12, or 85:6—compared to the 1:100 to 1:10,000 ratio disclosed in the present application.

Accordingly, the combined cited art fail to teach or suggest an element of claim 1 of the present invention, and Houchin in fact teaches away from the present invention. Claims 2-9, 21-23, and 25-26 all depend, directly or indirectly, from claim 1 and thus also are patentable over the cited art for at least the reasons discussed above. Reconsideration of the rejection and a Notice of Allowance are requested.

Ngan in View of Houchin in Further View of Ishizuka

The Examiner rejected claims 10 and 11 as obvious over Ngan and Houchin, as applied to claim 1, and further in view of Ishizuka et al. (U.S. Pat. No. 5,531,834)(“Ishizuka”). Applicant respectfully disagrees and requests reconsideration of the rejection.

Claims 10 and 11 depend from claim 1 and so are patentable over the cited art at least for the reasons cited above in connection with the rejection over Ngan in view of Houchin. Ishizuka does not disclose a helical ribbon coil as in the present invention, specifically, with a width substantially greater than a thickness.

Moreover, Ishizuka does not disclose a distance between the coil electrode and the workpiece of less than five inches. The disclosure cited by the examiner, Ishizuka Col. 12, ll. 34-43 and Fig. 1, states that the “maximum diameter of the antenna member 13 is set to be substantially equal to the diameter of the wafer W, ranging from 10 to 30 cm.” This disclosure refers not to the distance

between W and the electrode, but the *diameter* of each. The examiner admits that Ngan does not disclose that the distance between the helical electrode and the workpiece is less than five inches. Therefore, claims 10 and 11 are not obvious over the cited art, and Applicant respectfully requests reconsideration of the rejection.

Ngan in View of Houchin in Further View of Qian

The Examiner rejected claims 12-16, 24, and 27-29 as obvious over Ngan and Houchin, as applied to claim 1, and further in view of Qian et al. (U.S. Pat. No. 6,447,636) ("Qian"). Applicant respectfully disagrees and requests reconsideration of the rejection.

Claims 12-16 depend directly or indirectly from claim 1 and therefore are patentable at least for the reasons discussed above in connection with the section 103(a) rejection over Ngan in view of Houchin. Independent claim 24 contains essentially the same limitation relating to the width and thickness of the helical ribbon electrode ("a helical ribbon electrode adapted to excite the plasma, the helical ribbon electrode comprising an elongated cross-section and a plurality of ribbon coils stacked in flat concentric spirals . . .") and is patentable over the cited art for the same reasons set forth above. Claims 27-29 depend from claim 24 and also are patentable for the same reasons as claim 24.

The examiner admits that Ngan and Houchin do not teach a controller coupled to the RF plasma source to pulse the RF plasma source for each deposited layer. Nevertheless, regarding claim 24, the examiner indicates that Qian discloses a system controller coupled to the solid state RF plasma source to pulse the solid state RF plasma source for each deposited layer. Office Action at page 6, citing Qian at page [sic: Col.] 10, ll. 1-67.

Applicant respectfully disagrees that claim 24 is obvious over the cited art at least for the reasons cited above in connection with the helical ribbon coil.

The examiner further rejected claim 29 (dependent from claim 24) as obvious "without showing that the claimed ranges (ratio, width difference) achieve unexpected results relative to the prior art range," *i.e.*, a result that is unexpected as being different in kind, rather than degree. Office Action at page 7. Applicant respectfully submits that claim 29 is patentable over the cited art for the reasons provided above for claim 24.

Applicant further submits that unexpected results are set forth in the specification of the present application. By way of example only:

Conventional ALD equipment typically uses coils with the same width to height aspect ratio. The plasma density for the conventional equipment is focused at the coil. The density is high near the coil, and typically the density becomes uniform at about five inches from the coil. Such non-linearity in plasma density is undesirable.

Appln. at ¶ [0006].

The helical ribbon [of the present invention and having the ratio range set forth in claim 29] provides a highly uniform plasma and also results in a chamber with a small volume. The system enables high precision etching, deposition or sputtering performance.

Appln. at ¶ [0014].

Other advantages [of the system] may include one or more of the following: The system attains highly efficient plasma operation in a compact substrate process module that can attain excellent characteristics for etching, depositing or sputtering of semiconductor wafers as represented by high etch rate, high uniformity, high selectivity, high anisotropy, and low damage. The system achieves high density and highly uniform plasma operation at low pressure for etching substrates and for deposition of films on to substrates. Additionally, the system is capable of operating with a wide variety of gases and combinations of gases, including highly reactive and corrosive gases.

Appln. at ¶ [0015].

The large ratio of the width to the thickness of the ribbon electrode allows the short distance (less than 5 inches, and typically between 1 and 3 inches) and still offers the plasma uniformity required on the wafer surface.

Appln. at ¶ [0029].

The helical ribbon 170 enhances the uniformity of power

density due to its width/thickness ratio. Power transmittance is higher because the ribbon 170 is closer to the chamber. Hence, power loss is reduced. The ribbon 170 is low in profile, and supports a high density, low profile semiconductor processing system.

Appln. at ¶ [0036].

The foregoing excerpts from the specification indicate that the claimed helical ribbon electrode thickness to width ratio ranges, claimed in claim 29, produce new and unexpected results which are different in kind and not merely in degree from the prior art. Accordingly, claim 29 is not obvious and is patentable.

In light of the above, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and a Notice of Allowance is requested. The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

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